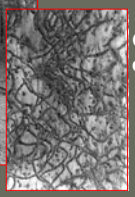
Bark Beetles (Continued)

The Southern Pine Beetle (*D. frontalis*)

- A huge scourge of all species of southern pines;
- Ranges from the NJ pine barrens to Nicaragua;
- In the American Southern Pine Region it completes a generation in 30 days (potentially 3-5 generations/yr); and
- Has a pronounced switching mechanism.

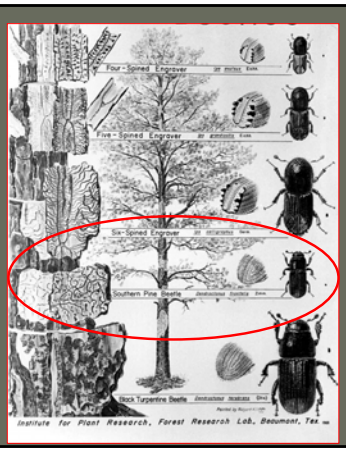
Within a SPB spot kill

Checking the brood



Gall-eries

Principal scolytids in southern pines.



" By the way, the SPB does have the typical-barkbeetle host selection behavior. You know, the female pioneer finding a focus tree during dispersal flight etc. etc."

A SPB spot begins…

Grows…

Encompasses the landscape…

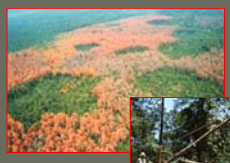
Patrol

Locate spots

Cut down

Spray

Original SPB control tactics: never worked.



Large SPB infestations were logged and logs sprayed with an insecticide at railroad landings.

Ok as a salvage operation but not as a control tactic.

Enter the Boyce Thompson Institute's SPB Experiment Station, near Sour Lake, Texas

Philosophy -- "if you're going to understand the host selection behavior of the SPB, you've got to live with the problem."

How do you study the host selection behavior?

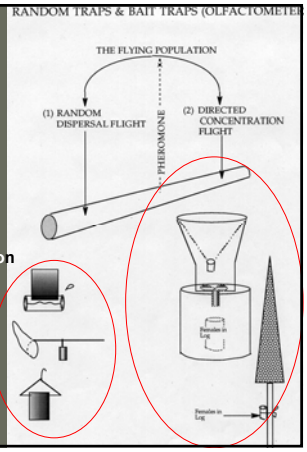
1st break down the components of host selection:
- random dispersal phase: random trapping
-- barrier traps or rotary nets.

- concentration flight phase: pheromone traps or placing attractive bolts on test trees.

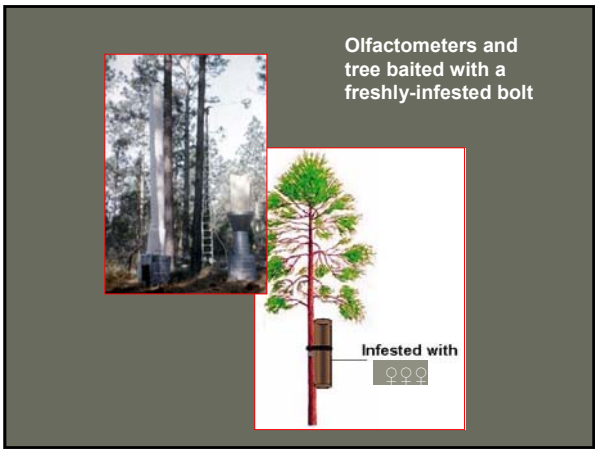
2nd study the response of the SPB and other southern barkbeetles to their pheromone. At the same time study the flight pattern of the SPB.

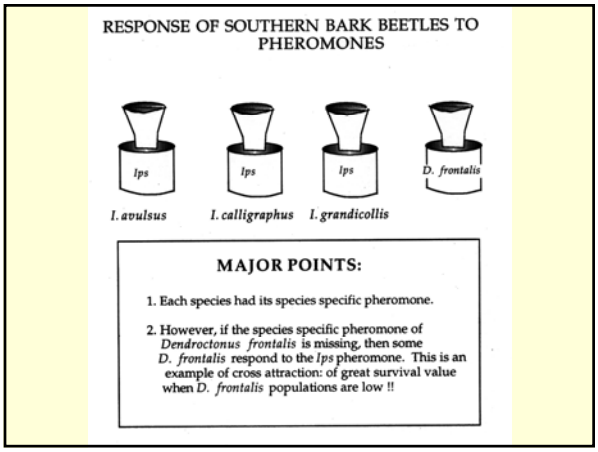
To study the random-dispersal flight: random trapping devices

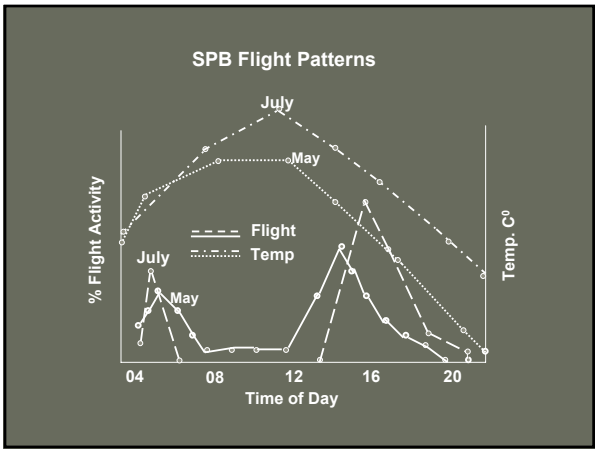
To study the directed-concentration flight: bait trapping



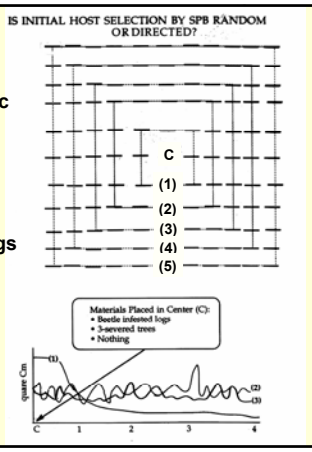
Random trapping devices: barrier traps and rotary nets


Olfactometers and tree baited with a freshly-infested bolt
Infested with


RESPONSE OF SOUTHERN BARK BEETLES TO PHEROMONES
Ips
Ips
Ips
D. frontalis
I. avulsus
I. calligraphus
I. grandicollis
MAJOR POINTS:
1. Each species had its species specific pheromone.
2. However, if the species specific pheromone of Dendroctonus frontalis is missing, then some D. frontalis respond to the Ips pheromone. This is an example of cross attraction: of great survival value when D. frontalis populations are low !!

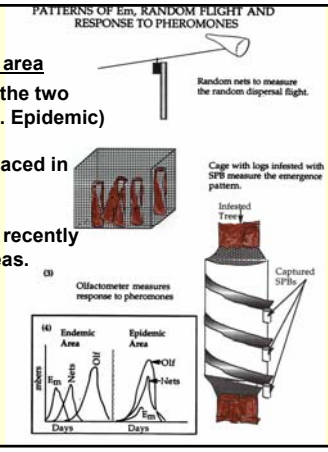

SPB Flight Patterns
July
May
Flight
Temp
July
May
% Flight Activity
Temp. C°
04
08
12
16
20
Time of Day

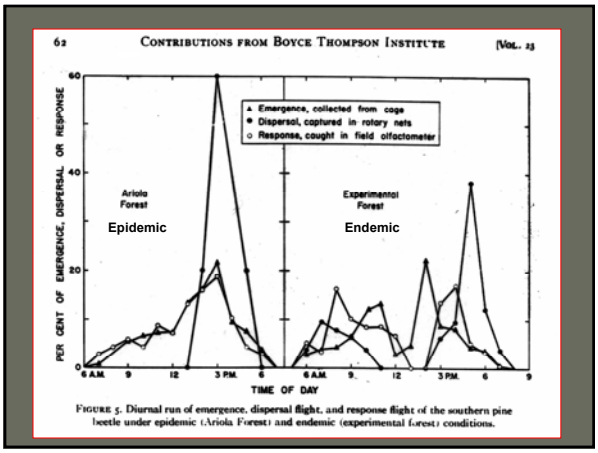
- Large squares of panels could be divided for sampling into 5 concentric squares (1 - 5)
- C is the center
- Material placed in C:
  - Beetle infested logs
  - Severed trees
  - Nothing
- SPB/sq. cm. were determined for each square.



Experiments within an endemic and epidemic area

- Random nets placed in the two forests (Endemic area vs. Epidemic)
- Logs with SPB brood placed in cages in both forests
- Olfactometer placed on recently infested trees of both areas.





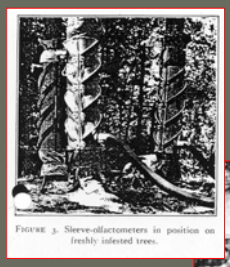


FIGURE 3. Sleeve-olfactometers in position on freshly infested trees.

Olfactometers and rotary nets: placed within an endemic SPB area & an epidemic area

Emergence devices to mark beetles, and rotary nets.

Olfactometer placed around freshly-infested tree.

1st test had no attractants in beetle-release area. There were beetle-marking devices and rotary nets.

1mi away

We counted marked and unmarked beetles caught in the olfactometer.

2nd test had fresh attractants in beetle-release area. There were beetle-marking devices and rotary nets.

1mi away

We counted marked and unmarked beetles caught in the olfactometer.

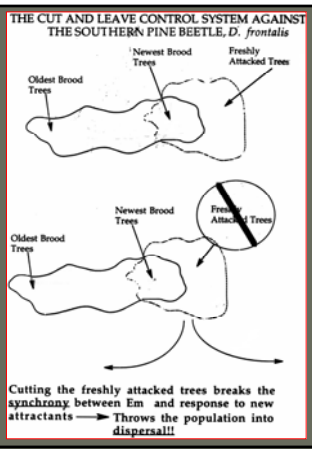
Look at the neat data!

Experimental Conditions			No. of Beetles Caught at Two Sites					
			At Release point nets			Olfactometers-1mi Away		
Attractant present at release pt.	Date	No. marked beetles released	Total no.	No. marked	% Recovery	Total no.	No. marked	% Recovery
None	6/26	295	0	0	0	210	9	3.0
None	6/27	198	0	0	0	185	7	3.5
None	6/28	172	0	0	0	180	5	2.9
None	6/29	164	0	0	0	100	[illegible]	1.2
None	6/30	83	0	0	0	243	[illegible]	1.2
		μ =182.4	0	0	0	μ=183.	[illegible] μ=4.8	μ=2.5
Four baited trees	7/3	276	73	7	2.5	110	0	0
Four b/trees	7/4	126	39	3	2.4	100	1	0.8
Four b/trees	7/5	178	66	7	1.0	132	0	0
Four b/trees	7/6	100	40	1	1.0	141	0	0
		μ =170.0	μ =49.5	μ =4.5	μ =2.6	μ =120.7	μ =0.25	μ =0.02

Zero

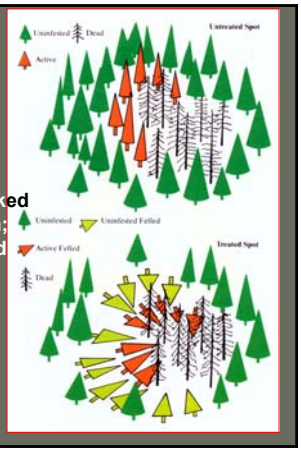
~3%

The cut & leave method to stop the spread of a SPB infestation.

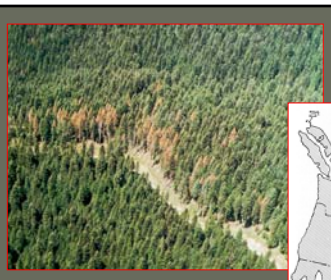


The Cut & Leave system to control SPB outbreaks.

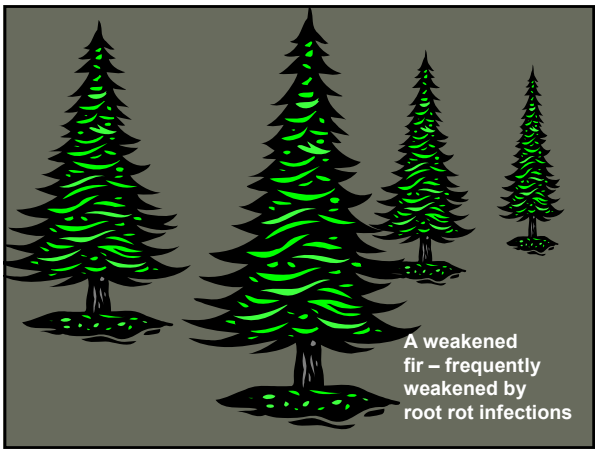
1. Identify the active trees;
2. Search for freshly-attacked trees and cut them down;
3. Cut a ring of un-attacked trees as well.

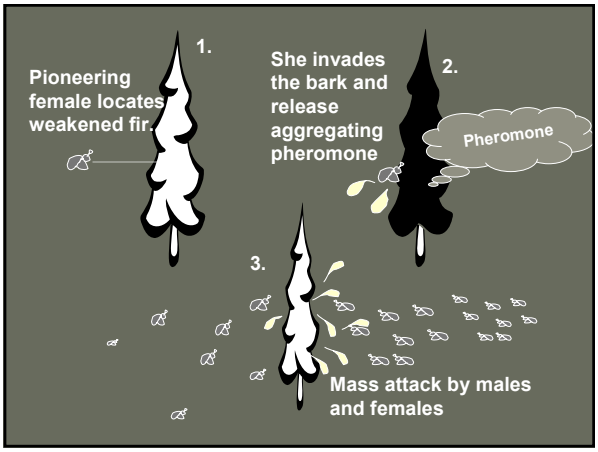


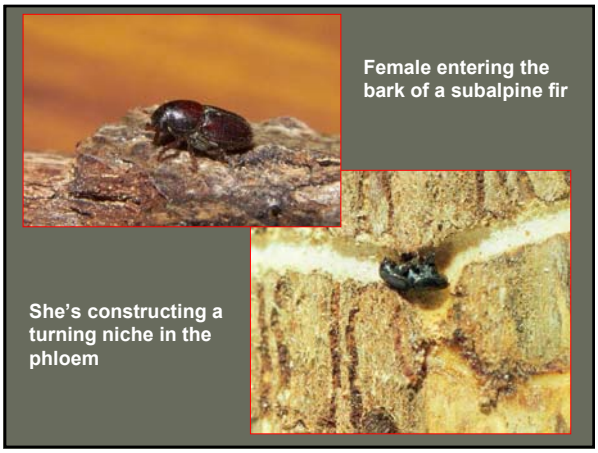
Scolytus ventralis, the fir engraver beetle

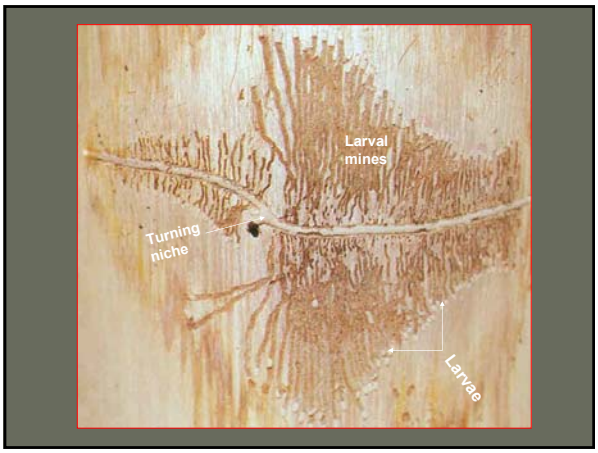


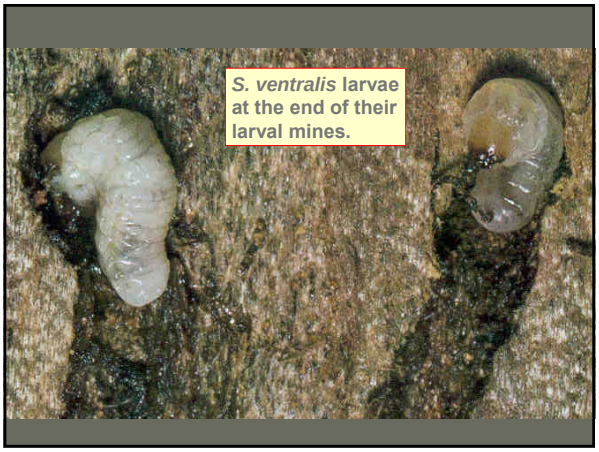
The fir engraver beetle kills true firs throughout the West

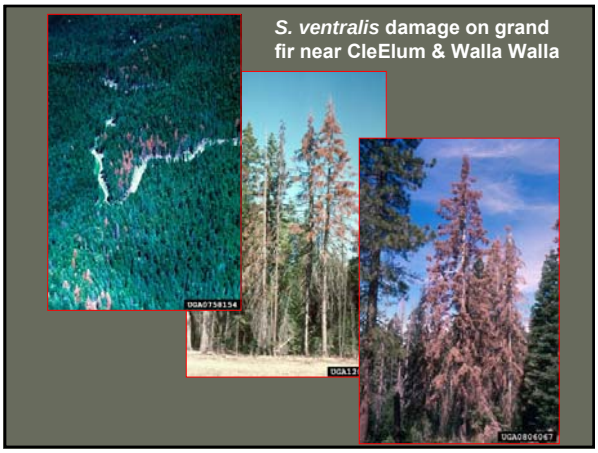

A weakened fir – frequently weakened by root rot infections


1.
Pioneering female locates weakened fir.
She invades the bark and release aggregating pheromone
2.
Pheromone
3.
Mass attack by males and females

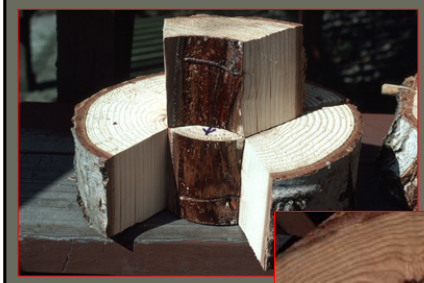

Female entering the bark of a subalpine fir
She's constructing a turning niche in the phloem

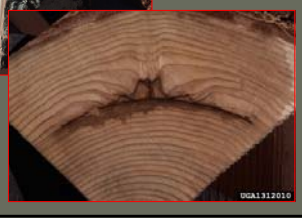

Larval mines
Turning niche
Larvae


S. ventralis larvae at the end of their larval mines.


S. ventralis damage on grand fir near CleElum & Walla Walla

Sometimes the trees wall-off the damage with resin. Often the beetles complete their life cycles: partial tree mortality is common.

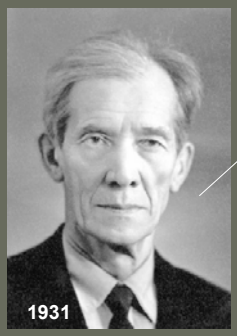




Partial attacks cause pitch pockets in the wood, or other defects.

Management of fir engraver beetle problems:

1. Silvicultural practices aimed at maintaining healthy stand conditions: thinning if feasible in conjunction with a WSBW control program;
2. Diseased, injured, or decadent trees should be removed;
3. Wind thrown trees and cut logs should be removed within the yr., before the beetles have had time to produce new broods;
4. Special attention should be paid to hazard trees within campgrounds and parks.

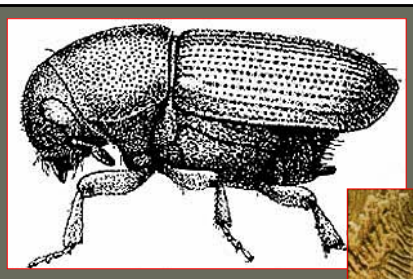


"…my gawd there's another huge problem that's been introduced last year -- the Dutch elm disease and its vector, *Scolytus multistriatus.*"

Called the Dutch elm disease because it was first reported and studied in Holland in 1919.

In 1930 a huge European elm log that carried both the disease and the bark beetles which

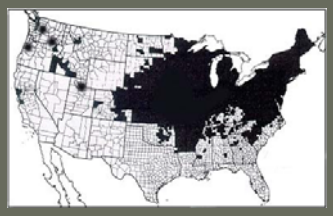
vector the fungus was brought into the U.S.A.: Rahway, N.J.

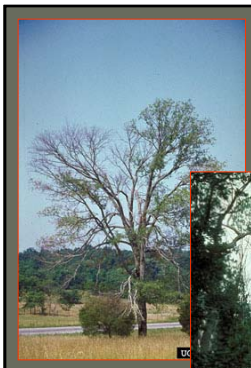


S. multistriatus and its gallery located under bark of a recently-killed American elm tree.

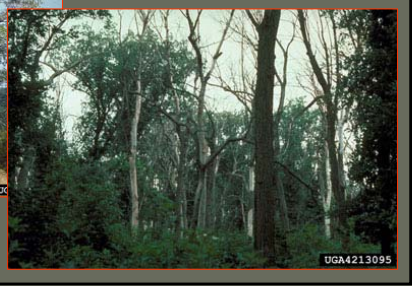
The Dutch elm disease is caused by a fungus called, *Ophiostoma ulmi* and there are several more aggressive strains, one called *O. novo-ulmi.*

The most important bark beetle that vectors the disease is the European elm bark beetle, *Scolytus multistriatus.*





The fungi and the bark beetle are effectively wiping out the American elm.



The link between the bark beetle and the disease is insidious and self generating: here are the steps in understanding this union.

elm weakened by disease and later killed by beetles

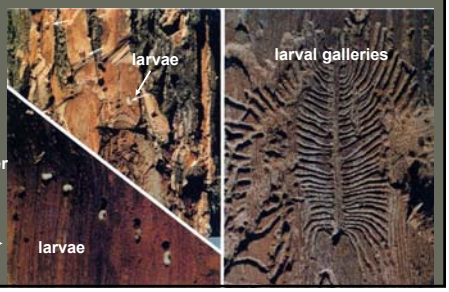
(step #1)

healthy elm

elm weakened by disease and later killed by beetles

(step #2)

bark beetle brood developing



S. multistriatus developing under bark of dead American elm

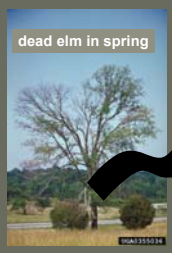
the bark beetle-killed elm tree

(step #3)

the bark beetle gallery where larvae are developing into adult *S. multistriatus*

coremia that contain sticky spores of the disease, *O. ulmi*, developing in the bark beetle galleries

(step#4)



The newly formed adult *S. multistriatus*, fly off in search of a new host -- but, the females are **sexually immature**!

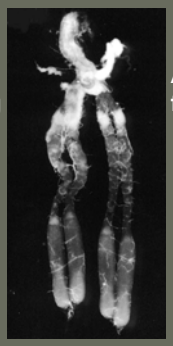
sticky spore → ← covered with spores

(step #5)

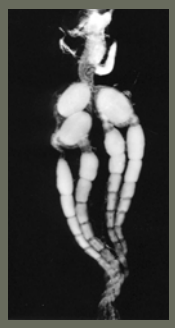
These sexually immature females have to fly to the top of a healthy elm. There they feed in the crotchlets of twigs and branches. In this manner, the females take up amino acids necessary to mature their ovaries.

Scolytus multistriatus ovaries

Before feeding



After feeding

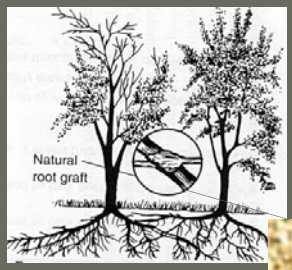


(step #6)

As the sexually immature females feed they deposit fungal spores in the feeding wounds.

The spores germinate and the developing vegetative growth of the fungus plugs the water-conducting tissues.

Branch by branch the tree wilts as water can't get to the foliage!!



Dutch elm disease also spreads from infected tree to healthy tree by root grafts.

You know when elms are infected by looking at the vascular tissues.

Management of the Dutch elm disease:

- prevent root grafting
- sometimes systemic fungicides work
- injecting competing fungi shows promise
- pruning to remove infected branches early in development of the disease
  there is promise that resistant elms will become available in the distant future
- hybrids between Siberian elms and American elms shows promise too

Planting Siberian elm to replace the loss of American elms.